Wastewater Management in Shale Gas Industry: Alternatives for Water Reuse and Recycling, Challenges and Perspectives

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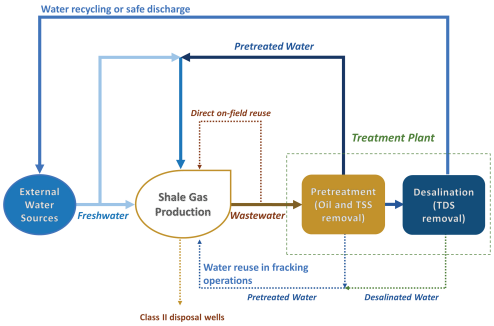

Wastewater management is nowadays one of the major concerns faced by the shale gas industry to improve its cost-effectiveness, while preserving the human health and environment [1]. Horizontal drilling and hydraulic fracturing «*fracking*» operations—required for the economically viable natural gas production from tight shale rocks—usually demand excessive freshwater consumption and generate large wastewater volumes [2]. Aside from chemical additives present in hydrofracturing fluids, wastewater is also composed by the shale formation constituents, which can include organic matter, naturally occurring radioactive materials (NORM), and high concentrations of salts and scale-forming ions [3]. The highly polluting nature of shale gas wastewater impels the application of energy-intensive pretreatment and desalination, to allow water reuse in hydraulic fracking processes, water recycling or safe discharge.

Different management alternatives can be used for shale gas wastewater to reduce socioeconomic, public health and environmental risks. Around 95% of the shale gas wastewater totality produced by the U.S., is currently disposed in Class II saline water wells through conventional underground injection [4]. Although deep-well injection still remains as the dominant practice mainly due to economic reasons, factors related to capacity restrictions and potential groundwater and soil contamination and induced seismic activity, have recently arisen as driving forces for the application of advanced managing strategies.

Water reuse for internal shale gas operations is another beneficious alternative to address both the freshwater resources depletion and wastewater pollution. Yet, direct wastewater reuse is generally inappropriate owing to its elevated contamination, which can hinder the shale well exploration. In this case, onsite pretreatment plants containing primary and secondary treatment technologies for greases, oil, scaling material and total suspended solids (TSS) removal, can be implemented to prevent operating problems. Apart from practical and capacity constraints of onsite treatment units, internal reuse alternative is ultimately dependent on the growth in shale gas production. As the demand for new wells exploitation tends to decrease with the industry maturity, shale gas activity will turn into a wastewater producer. Then, (offsite) desalination units will become inevitable to achieve the high-quality needed for water recycling or release to surface water bodies.

High energy consumption and greenhouse gas emissions, as well as specific operational problems (fouling and scaling) are challenges for the further development of emerging zero-liquid discharge desalination technologies. Firmer environmental regulations on brine discharges and water quality, and regulatory incentives will eventually guide the shale gas industry towards a cleaner future.

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